

TABLE I. Recommended $B(E2;0_1^+ \rightarrow 2_1^+)$ and β_2 values for $2\beta^-$ candidates.

Parent	$E(2_1^+)$, keV	$B(E2)\uparrow$, W.u.	β_2	Daughter	$E(2_1^+)$, keV	$B(E2)\uparrow$, W.u.	β_2
⁴⁶ Ca	1346.0 (3)	3.61(+32-15)	0.1505(+66-31)	⁴⁶ Ti	889.286 (3)	19.42(52)	0.3175(42)
⁴⁸ Ca	3831.72 (6)	1.768(+234-96)	0.1054(+70-29)	⁴⁸ Ti	983.5390 (24)	12.77(56)	0.2575(56)
⁷⁰ Zn	884.46(8)	17.80(88)	0.2229(55)	⁷⁰ Ge	1039.485(22)	19.61(77)	0.2194(43)
⁷⁶ Ge	562.93(3)	28.16(+79-76)	0.2629(+37-36)	⁷⁶ Se	559.102(5)	45.14(+157-59)	0.3133(+55-20)
⁸⁰ Se	666.27(7)	24.62(80)	0.2314(38)	⁸⁰ Kr	616.60(10)	37.2(11)	0.2686(41)
⁸² Se	654.75(16)	17.3(9)	0.1939(53)	⁸² Kr	776.520(3)	21.28(+63-58)	0.2031(+30-28)
⁸⁶ Kr	1564.75(10)	9.36(84)	0.1347(60)	⁸⁶ Sr	1076.68(4)	11.89(68)	0.1439(41)
⁹⁴ Zr	918.75(5)	4.96(35)	0.0882(31)	⁹⁴ Mo	871.098(16)	16.32(58)	0.1525(27)
⁹⁶ Zr	1750.497(15)	2.38(32)	0.0611(41)	⁹⁶ Mo	871.098(16)	16.32(58)	0.1525(27)
⁹⁸ Mo	787.384(13)	20.09(43)	0.1692(18)	⁹⁸ Ru	652.44(4)	29.89(97)	0.1970(32)
¹⁰⁰ Mo	535.561(22)	38.4(16)	0.2340(49)	¹⁰⁰ Ru	539.510(10)	35.74(30)	0.21539(90)
¹⁰⁴ Ru	358.02(7)	56.9(12)	0.2717(28)	¹⁰⁴ Pd	555.81(4)	36.4(10)	0.2080(29)
¹¹⁰ Pd	373.80(6)	55.3(15)	0.2562(34)	¹¹⁰ Cd	657.7645(20)	27.20(68)	0.1722(22)
¹¹⁴ Cd	558.456(2)	32.63(46)	0.1886(13)	¹¹⁴ Sn	1299.907(7)	12.69(67)	0.1130(30)
¹¹⁶ Cd	513.490(15)	34.51(89)	0.1940(25)	¹¹⁶ Sn	1293.560(8)	11.67(38)	0.1083(18)
¹²² Sn	1140.51(3)	10.38(49)	0.1021(24)	¹²² Te	564.094(16)	36.18(+73-69)	0.1834(18)
¹²⁴ Sn	1131.739(17)	9.11(23)	0.0957(12)	¹²⁴ Te	602.7271(21)	31.6(16)	0.1713(45)
¹²⁸ Te	743.219(7)	19.83(37)	0.1358(13)	¹²⁸ Xe	442.911(9)	40.2(16)	0.1862(37)
¹³⁰ Te	839.494(17)	15.21(36)	0.1189(14)	¹³⁰ Xe	536.068(6)	30.8(+14-11)	0.1630(+38-28)
¹³⁴ Xe	847.041(23)	16.5(13)	0.1192(48)	¹³⁴ Ba	604.7223(19)	32.63(95)	0.1617(23)
¹³⁶ Xe	1313.027(10)	13.8(39)	0.109(15)	¹³⁶ Ba	818.497(11)	19.87(+54-53)	0.1262(17)

and the original research papers. All measurements were separated into three classes: model independent, low model dependent and model dependent [4, 7]. The recommended $B(E2)\uparrow$ values were deduced using model-independent or traditional, combined (model-independent and low model-dependent), and model-dependent datasets with the AveTools software package [11] using the selected datasets. The final results were analyzed using the shell model predictions. A subset of evaluated and calculated data for Ni nuclei is shown in Fig. 2.

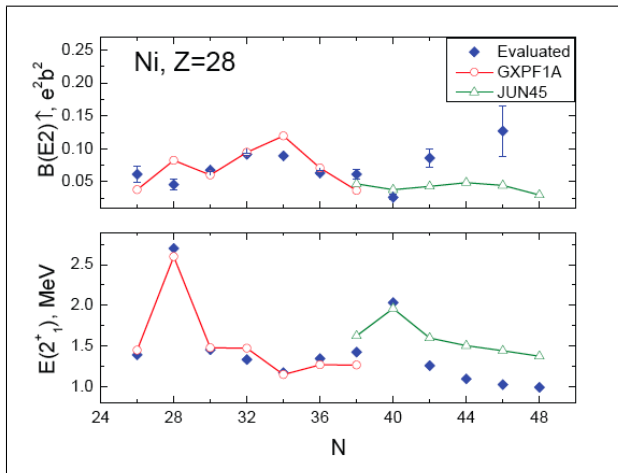


FIG. 2. Brookhaven-McMaster-Central Michigan evaluated $B(E2)\uparrow$ values and 2_1^+ energies vs. shell-model calculations for Ni [7].

As an example, consider a non-traditional application of $B(E2)\uparrow$ evaluation. In recent years a considerable

amount of effort has been dedicated to the search for double-beta decay transitions to the first excited states [12]. Two-neutrino double-beta decay half-lives for the transitions to the first excited 2^+ and 0^+ states are often computed on the basis of a second Quasi Random Phase Approximation (QRPA) and Hartree-Fock-Bogoliubov models [13, 14]. The deformed QRPA using the realistic Bonn-CD nucleon-nucleon interaction approach has been applied recently for the neutrinoless mode [15]. The reliability of these calculations has been tested by comparing theoretically calculated results for a number of spectroscopic properties such as reduced transition probabilities with evaluated data. To facilitate such calculations, two subsets of evaluated nuclear structure data for $2\beta^-$ -decay and $2\beta^+$ -, $\epsilon\beta^+$ - and 2ϵ -decay candidates [16] are shown in Tables I and II, respectively. These tables reflect current progress and indicate future work.

III. CONCLUSIONS

The $B(E2)\uparrow$ evaluation is proceeding under the auspices of the U.S. Nuclear Data Program. This effort is continuation of the previous works of Stelson, Grodzins and Raman [1–4]. This procedure includes the broadened nuclear structure data sets supported by shell model calculations for all known even-even nuclei.

The subset of the latest quadrupole collectivity data relevant to double-beta decay problem has been noted [16]. These well-established data could provide some guidance for theoretical calculations of double-beta decay rates for nuclei of interest where information on Gamow-Teller transitions is lacking.

The data evaluation for the $Z\sim 28$ nuclei [7] is publicly

TABLE II. Recommended $B(E2;0_1^+ \rightarrow 2_1^+)$ and β_2 values for $2\beta^+$, $\epsilon\beta^+$ and 2ϵ candidates.

Parent	$E(2_1^+)$, keV	$B(E2)\uparrow$, W.u.	β_2	Daughter	$E(2_1^+)$, keV	$B(E2)\uparrow$, W.u.	β_2
⁵⁰ Cr	783.3(9)	19.32(42)	0.2903(32)	⁵⁰ Ti	1553.778 (7)	5.04(30)	0.1617(48)
⁵⁸ Ni	1454.21(9)	10.04(17)	0.1794(15)	⁵⁸ Fe	810.7662(20)	16.9(24)	0.250(18)
⁶⁴ Zn	991.56(5)	19.52(68)	0.2335(41)	⁶⁴ Ni	1345.75(5)	8.3(5)	0.163(5)
⁷⁴ Se	634.74(6)	38.7(21)	0.2902(80)	⁷⁴ Ge	595.850(6)	32.68(+90-81)	0.2832(+39-35)
⁷⁸ Kr	455.033(23)	64.0(16)	0.3524(44)	⁷⁸ Se	613.727(3)	34.6(12)	0.2744(49)
⁸⁴ Sr	793.22(6)	26.7(21)	0.2156(84)	⁸⁴ Kr	881.615(3)	11.60(+44-25)	0.1500(+29-16)
⁹² Mo	1509.51(3)	7.90(35)	0.1061(23)	⁹² Zr	934.47(5)	6.49(32)	0.1009(25)
⁹⁶ Ru	832.56(5)	18.22(50)	0.1538(21)	⁹⁶ Mo	778.237(10)	21.26(45)	0.1740(19)
¹⁰² Pd	556.44(5)	32.5(16)	0.1965(49)	¹⁰² Ru	475.0962(10)	44.68(88)	0.2408(24)
¹⁰⁶ Cd	632.64(4)	27.32(83)	0.1726(26)	¹⁰⁶ Pd	511.850(23)	44.3(12)	0.2294(30)
¹¹² Sn	1256.85(7)	14.47(58)	0.1206(24)	¹¹² Cd	617.520(10)	30.02(91)	0.1810(27)
¹²⁰ Te	560.438(20)	40.3(20)	0.1936(47)	¹²⁰ Sn	1171.265(15)	11.23(29)	0.1062(14)
¹²⁴ Xe	354.04(4)	59.8(+24-21)	0.2269(+46-40)	¹²⁴ Te	602.7271(21)	31.6(16)	0.1713(45)
¹³⁰ Ba	357.38(8)	58.2(24)	0.2159(44)	¹³⁰ Xe	536.068(6)	30.8(+14-11)	0.1630(+38-28)

available and the whole $Z=2-56$ region is completed. The evaluation of the $Z>56$ region is currently underway and will become available in the next few years.

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